

**Interface Definition Document (IDD)
& Payload Accommodations Handbook
for the
Deep Space Test Bed (DSTB) Facility
Continental United States
Engineering Flight
March 15, 2005**

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Acronym List

A	Amps
AC	Alternating Current
AL	Alabama
atm	atmosphere
C	Celsius
CONUS	Continental United States
Deg	Degree
DC	Direct Current
DSTB	Deep Space Test Bed
FCDS	Flight Computer and Data System
FRR	Flight Readiness Review
g	Gravitational Force
GCR	Galactic Cosmic Ray
GPS	Global Positioning System
GSE	Ground Support Equipment
ICD	Interface Control Document
ID	Identification
IDD	Interface Definition Document
I/O	Input / Output
lbs.	Pounds
LDB	Long Duration Balloon
LEO	Low Earth Orbit
mb	millibars
MHz	Mega Hertz
NASA	National Aeronautics and Space Administration
NRA	National Research Agreement
NSBF	National Scientific Balloon Facility
NSSTC	National Space Science and Technology Center
PC	Personal Computer
POC	Point of Contact
ps	pico seconds
SIP	Standard Instrumentation Package
SRSP	Space Radiation Shielding Program
TBD	To Be Determined
TX	Texas
V	Voltage
VDC	Voltage Direct Current
W	Watts

1.0 Introduction

1.1 Purpose

The purpose of this document is to provide a “handbook” for individuals developing hardware for the Deep Space Test Bed (DSTB) Facility during its Certification test flight. The information will provide investigators an understanding of the interfaces, requirements and environments that their instrument will encounter during assembly, ground testing, transportation, flight, landing and post flight transportation.

1.2 Background

The DSTB facility is a platform designed to expose experiments and instrumentation to Galactic Cosmic Rays within the bounds of the Earth’s atmosphere. This is accomplished by attaching the DSTB facility to a Long Duration Balloon and launching it from the Antarctic where the Earth’s converging magnetic fields allow the Galactic Cosmic Rays to penetrate down through the atmosphere. The Long Duration Balloons take the DSTB facility to altitudes of 130,000 ft (39.62 km). To insure that the DSTB facility is capable of withstanding the loads and stresses placed on it by this balloon flight the National Scientific Balloon Facility requires an engineering flight test to be preformed at one of their facility in the Continental United States (CONUS). The DSTB gondola for this engineering test flight has to closely approximate the weight, mass, size and configuration of the gondola structure that will be used in actual scientific flights. But due to the location and short duration of the engineering test flight most of the scientific payloads that are on the actual flight will not be used. Therefore the DSTB team has open these slots to people that would be interested in the data they can collect from short duration a high altitude balloon flight.

1.3 Engineering Test Flight Description

The DSTB Engineering Test Flight will originate from either of the NSFB CONUS flight facilities in Palestine TX or Ft. Sumner, NM. The Long Duration Balloon will reach an altitude of some where between 100,000 and 120,000 ft (30.48 and 36.58 km). The duration of the flight will range from 1 hour to 12 hours. Presently the time frame for this flight is May of 2005. Instruments are due to the DSTB Facility no later that March 1st 2005.

1.4 LEGAL disclaimers

It should be noted that owing to the nature of balloon flights and the remoteness of most flight paths there is no guarantee that a payload will be recovered. Nor is there any guarantee that recovery will include all equipment or data. Recovery plans will be at the discretion of NSBF, DSTB, NASA and the Federal government as well as other entities not specifically listed. **If you cannot afford to lose it, don’t use it!**

The DSTB Management Team reserves the right to refuse transport aboard the DSTB facility if the instrument being presented does not comply with the project requirements or does not meet standard safety requirements and practices for balloon payloads.

2.0 Reference documents

NSBF Recommendations for Gondola Design
Small Explorer Class Library, Long Duration Balloon Opportunities
National Scientific Balloon Facility, Long Duration Balloon Flight FY'04
Application Form and Enclosures
XD50 Safety Plan for General Laboratory Work
NSBF Ground Safety Plan

3.0 Deep Space Test Bed Facility Description

The DSTB Facility has four major subsystems: Mechanical, Flight Computer and Data System (FCDS), Power, and Thermal. A brief description of each of these is given in the following Sections.

3.1 Mechanical System

The DSTB Facility Mechanical System is a self-contained gondola, which houses the investigators instruments, data and command electronics and the power system. The Facility contains 5 functional levels shown in Figure 1. Starting at the top they are: the exposure deck, the electronics deck, the Balloon Support Instrument Package (SIP), the SIP solar panels and the DSTB solar panels. The SIP and SIP solar panels are provided by NSBF.

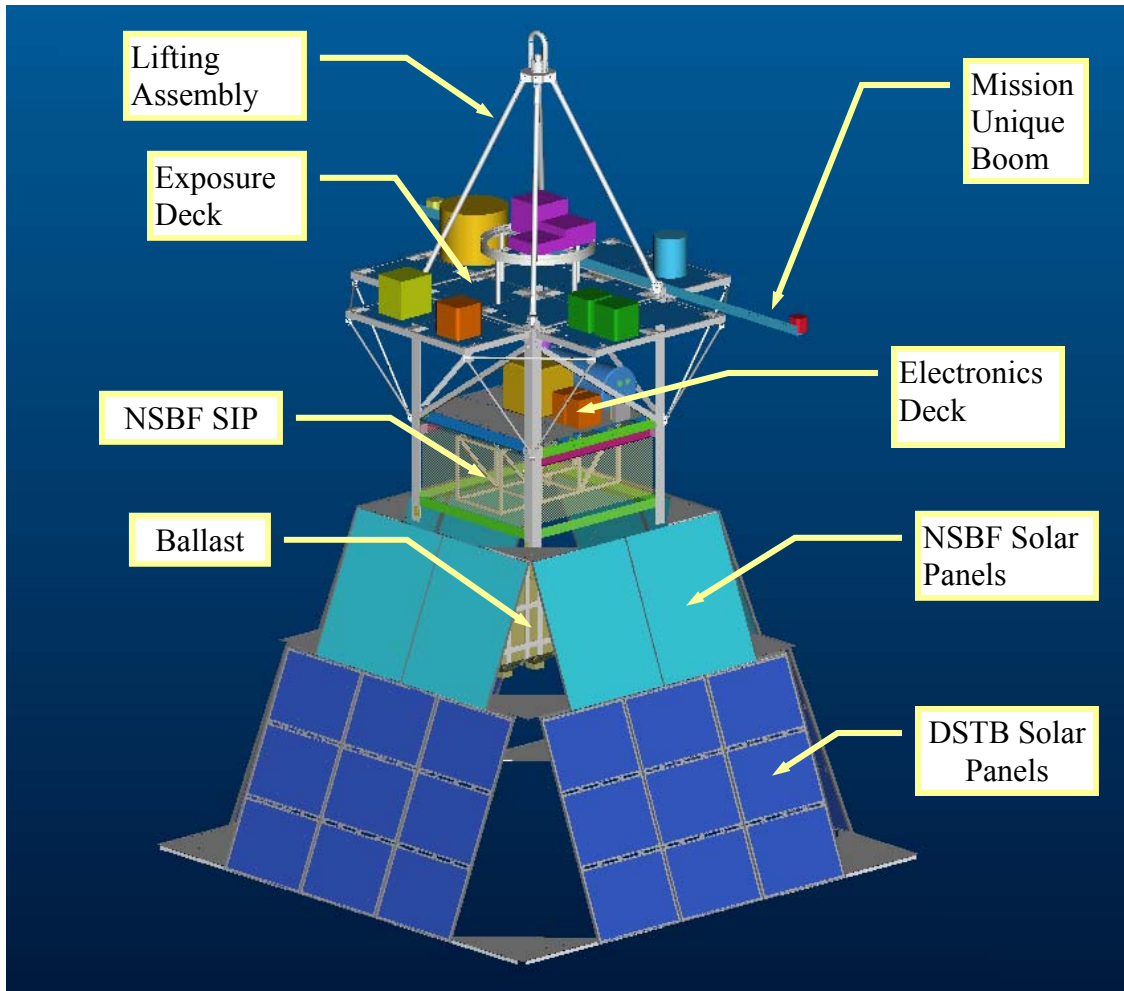


Figure 1: DSTB Configuration

The exposure deck will house most of the investigators instruments for each mission. This deck can be reconfigured to meet the requirements of a particular mission; however, it will have a basic structure consisting of replaceable panels. The design has 12 separate panels approximately $25.8" \times 25.8"$ ($65.53\text{cm} \times 65.53\text{cm}$), each a mounting platform for investigators. The panels fit within the perimeter of the upper deck. Additional space is available on the electronics deck for investigators electronics. The exposure deck is also capable of holding a carousel of shielding materials. Detectors will be placed below the carousel to measure the transmitted radiation. In special cases small instruments may be placed on booms extending from the gondola, away from the central mass of the DSTB.

The electronics deck is located directly beneath the exposure deck. This platform houses the Flight Computer and Data System (FCDS) electronics and all of the major Power System components except for the solar panels. This reduces the mass on the exposure deck that can influence the radiation environment for the experiments. There will be space available on the electronics deck for investigator's instruments and/or electronics that do not require direct exposure.

The NSBF SIP is located directly below the electronics deck. Although the SIP itself is

provided by NSBF, the structure for mounting the SIP is being provided by the DSTB Facility.

The solar panels for the SIP and DSTB are located below the SIP at the bottom of the gondola. The SIP solar panels will be provided by NSBF. The DSTB solar panels, in conjunction with the DSTB batteries, supply power to all of the DSTB electronics and the investigators' instruments.

The ballast, supplied by the NSBF, will be suspended from the 4 main support angles below the SIP.

Further information concerning experiment mechanical interfaces is in Section 4.

3.2 Flight Computer and Data System

The FCDS is an electronic data acquisition and control system whose primary functions are:

1. To provide the communications and control interface between the DSTB Facility investigator instruments and the NSBF SIP. The SIP in turn provides links to the ground, allowing data to be sent from the experiments to the ground and commands to be sent from the ground to the experiments.
2. To provide on-board storage of experiment data.
3. To measure and report the state of the experiments and the DSTB Facility status (temperatures, pressures, currents, etc.).
4. To provide GPS location and time as requested by experiments.
5. To operate the DSTB Facility autonomously if communication with the ground is lost.
6. To control power to the experiments.

The FCDS consists of two components: a PC104 computer and the Smart Data Connector (SDC). The PC104, physically located on the electronics deck, will use mostly commercial off-the-shelf equipment and will be configured similarly from flight to flight. One SDC will be physically located on or near each instrument's panel and will provide a RS232/RS422 data interface to each instrument. In addition the SDC can monitor temperatures in the immediate experiment environment and provides some current switching capability.

Further information on the FCDS and instrument interface is in Section 4.

3.3 Power System.

The DSTB Facility power system provides power to the electronics deck and the investigator's instruments. It consists of solar arrays, batteries, a regulator/battery charging system, remote re-settable circuit breakers, and DC-DC converters. The remotely operated circuit breakers provide on/off power switching and current overload protection to the experiments. The power system can provide up to 600 watts (to be divided among experimenters) at 28 ± 6 VDC.

Further information on the Power interface to instruments is in Section 4.

3.4 Thermal System.

The DSTB Facility thermal system must ensure that all equipment on board will not be subjected to temperature or thermal stresses beyond their operating limits. It is anticipated that the required thermal environment can be achieved through the use of passive methods, e.g. thermal coatings and insulation. Thermal analysis will be used to determine the configuration of the thermal system. The DSTB organization will be responsible for the thermal modeling of the integrated DSTB Facility while each principal investigator will provide the thermal parameters of his individual instrument.

Further information on the Thermal system interface is in Section 4.

4.0 Experiment to DSTB Facility Interfaces

4.1 Introduction

The following Sections describe in more detail the DSTB subsystems and give information concerning the interfaces to the investigation instruments accommodated on the Deep Space Test Bed Facility.

4.2 Exposure Deck

4.2.1 Mechanical Interface

The Exposure Deck mechanical interface design consists of 12 separate panels each of which is a mounting platform for experiments. Note: Only the 8 exterior locations will be available for the CONUS flight. The panels fit within the perimeter of the upper deck, see Figure 2. The 4 interior panels and 8 exterior panels measure 25.8" x 25.8" x 0.25" (65.53cm x 65.53cm x .64cm) (Figure 3). This panel is provided by NSSTC. A Panel can be tailored by the individual experimenter as long as bolting and connector locations are followed per Figure 3 (Drawing DSTB-MECH-100). These panels are removable, allowing the investigator to take them to their home facility for integration. Each panel is designed to support up to 150 lbs (68.04 kg) of experiment weight and will have the hole and cut out configurations shown in Figure 3. The orientation of the holes and cut outs will depend on the placement of the panel on the exposure deck. The hardware can be attached to the panel by fasteners which meet the grounding and thermal requirements described in Section 5.

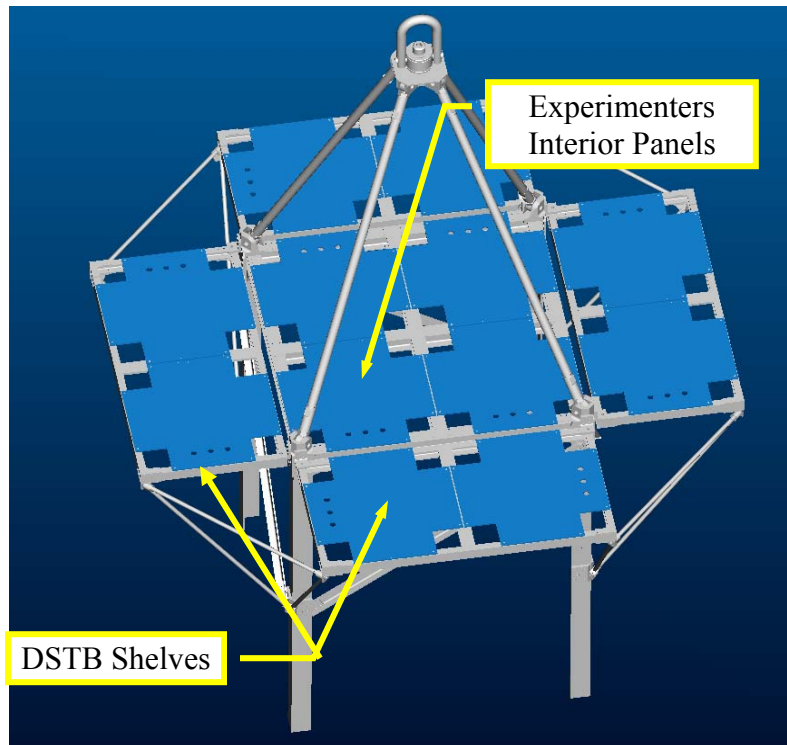


Figure 2: DSTB Facility Exposure Deck.

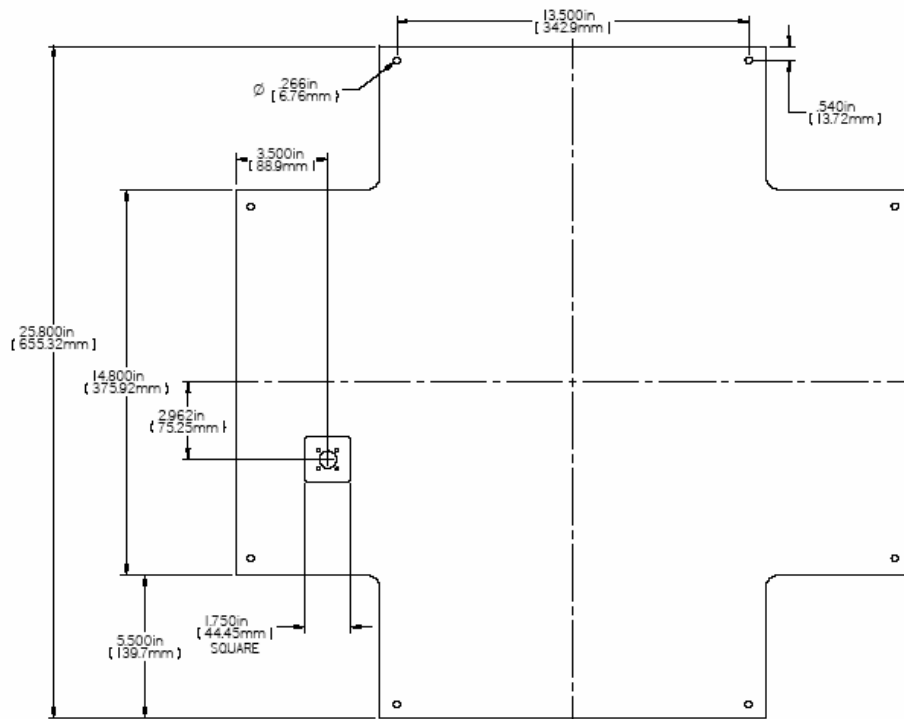


Figure 3: DSTB Exposure Deck Panel.

4.2.2 Power Interface

The DSTB Facility Power System consists of a set of solar panels connected in parallel, two 12V rechargeable sealed lead-acid batteries connected in series, a 24V

regulation/battery charging system, two 28V DC-DC converters connected in parallel, and relays and circuit breakers for switching power on and off to the loads. This system will interface with the experiment through the power connectors listed below located on the experimenters mounting panel. The power provided during the flight will be 28 ± 6 VDC and the watts per instrument will be based on the total 600 watts divided among the number of instrument on the flight and will be determined on a case by case basis. The power the experimenter needs should be part of their proposal to start discussions.

Power Receptacle Connector: P/N MS27656T11B5P

Connector and pins will be supplied by DSTB. 5 Pins, 7.5 Amps per pin using 20 AWG wire. Contact size is 20, military part number M39029/58-363. Pins require crimp tool M2250/1-01 with turret M22520/1-02 available from Daniels Manufacturing Corp. Soldering a wire to the pin is an option given that no solder is allowed on the outside surfaces of the pin. The following table shows the pin assignment for the power connector.

Power Connector Pin Assignments

A	+28VDC
B	28V Return
C	Chassis Ground
D	Unassigned
E	Unassigned

4.2.3 Flight Computer and Data System Interface

The FCDS provides a total of 20 Gigabytes of onboard data storage during the LDB flight. This amount will be divided among the experiments (individual amounts will be determined after a flight's manifest is decided). In addition telemetry of data is available during the flight in one of two modes: Line of Sight (LOS) and continuous. LOS data is available while the payload is within approximately 100 nm of McMurdo. The maximum LOS data rate for the facility will be 700 kbit. This bandwidth must be shared among all experiments. When LOS is not available telemetry will be through TDRSS satellite relay. This bandwidth also must be shared among all experiments. For a fully loaded DSTB facility flight the average rate for any one experiment must be less than 30 bytes/sec. Consult with DSTB personnel for the particular flight average rate specification. Bursting of data is allowed as long as the average rate is kept within specifications.

The SDC provides the physical layer between the FCDS and an instrument. The instrument interface is provided through asynchronous serial ports that may be configured as RS232 or RS422. Baud rates of 2.4k to 115.2k are supported. The SDC will provide a Low Rate (LR) serial port for data to be transmitted through TDRSS to the GSE and a High Rate (HR) serial port for data to be transmitted through the LOS or stored in the 1 gigabyte of allotted onboard storage.

The SDC power consumption is approximately 3.5 watts. This power is considered part of the instruments overall power allocation. The investigator is responsible for providing power to the SDC from the power connector. SDCs will operate on the primary bus voltage of +28VDC. The SDC is housed in an aluminum enclosure as shown in Figure 4.

For more specific interface information see the SDC Specification and User's Manual which can be found on the DSTB website at:

<http://sd.msfc.nasa.gov/cosmicray/DSTB/DSTB.htm>

For information concerning electrical grounding see the 'Deep Space Test Bed Grounding Plan' which can be found on the DSTB website.

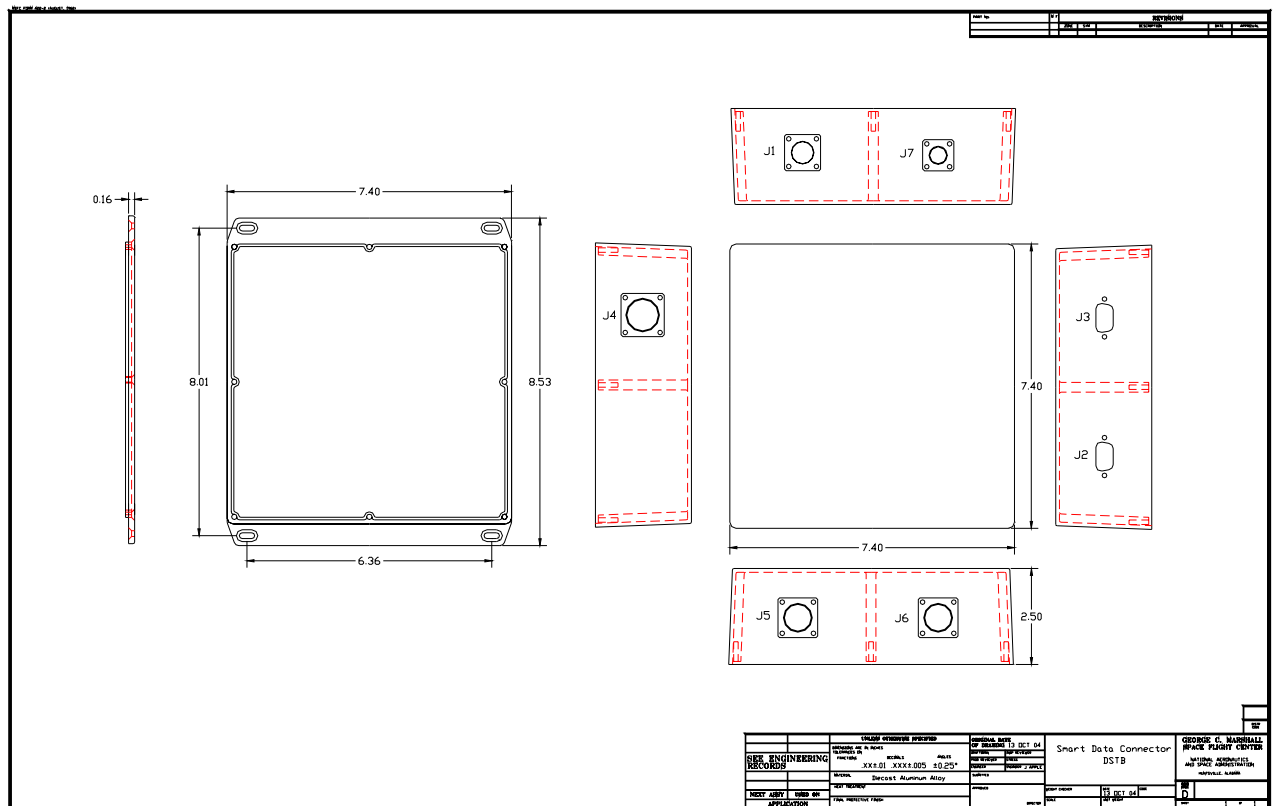


Figure 4: SmartPort Box.

4.2.4 Thermal Interface

The major sources contributing to the thermal environment of the DSTB balloon flight missions are (1)-direct solar radiation, (2)-reflected solar radiation from the Earth (albedo), and (3)-infrared radiation from the Earth. The nominal solar flux experienced during the Austral summer season is 1348 Watts/m² (1134 watts/yd²) with the Earth's albedo being as high as 95% when the balloon trajectory encounters a fresh blanket of snow. At lower altitudes as the balloon ascends through the troposphere the ambient air temperature may reach -65°C (-85°F). However, when float altitude is approached, convection becomes negligible due to the low ambient pressure. Temperature and Pressure requirements are given in Section 5.

In general thermal control of the DSTB will be via passive thermal absorption and radiation. Passive methods will be employed to control the instrument temperature within predefined limits and, if necessary, reduce the temperature gradient in critical areas of the payload. This requires specifying the insulation materials, the surface optical coatings and radiant heat exchange, and conduction paths to establish a temperature profile for each instrument over the course of a balloon flight. Some of the investigators may want to thermally isolate their instruments from the DSTB gondola. Some power may be available for heating and cooling to further control the temperature of individual instruments. Specifically, power dedicated to thermal control may be required during the pre-launch preparation, ascent and flight phases of the DSTB. Any active thermal protection needed during the flight will be negotiated with by the DSTB program and become a part of the instrument's power allotment as specified in the ICD.

4.3 Electronics Deck

The instruments and/or associated hardware mounted on this deck will be handled on a case by case basis.

4.3.1 Mechanical Interface

Instrument equipment located on the Electronics Deck will be attached by means that meet the Mechanical Requirements given in Section 5.

4.3.2 Power Interface

Equipment located on the Electronics Deck will utilize the connectors provided for the instruments on the exposure deck panel.

4.3.3 Flight Computer and Data System Interface

Equipment located on the Electronics Deck requiring communication with the FCDS will utilize the connectors provided for the instruments on the exposure deck panel.

4.3.4 Thermal Interface

Equipment located on the Electronics Deck will be treated with the same thermal interface requirements as instruments located on the Exposure Deck.

4.4 Boom

The Boom, see Figure 5, is designed to hold a passive instrument as far away from the main structure of the DSTB gondola as practical.

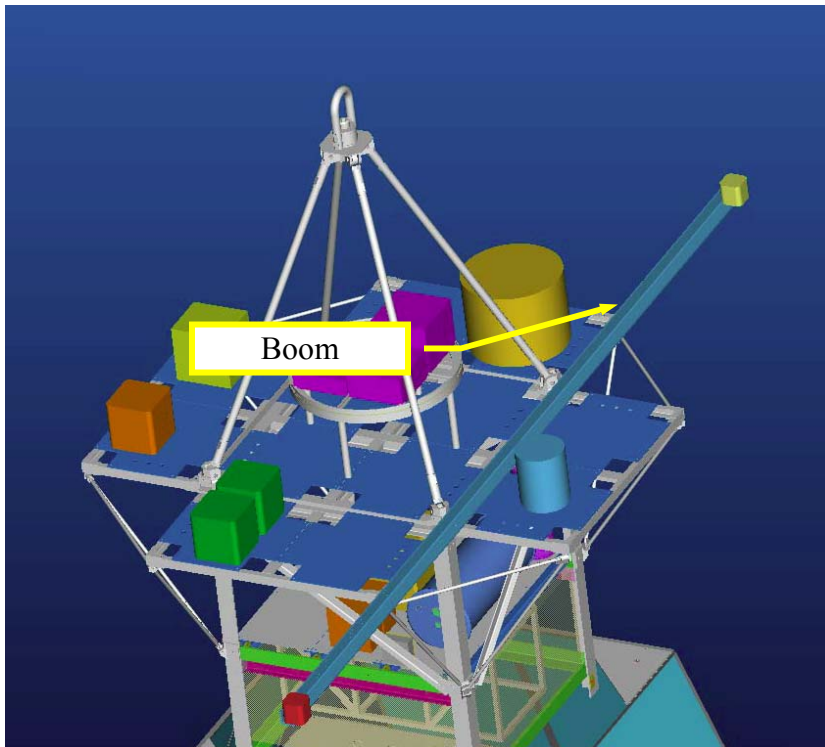


Figure 5: Mission Particular Carousel and Boom

4.4.1 Mechanical Interface

Instruments and Detectors located on the Boom will be mechanically attached by means that meet the requirements in Section 5.

4.4.2 Power Interface

Detectors or instruments located on the Boom requiring power will run cabling along the boom extension down to the Power Distribution located on the Electronics deck.

4.4.3 Flight Computer and Data System

Detectors or instruments located on the Boom requiring communication with the FCDS will interface by running cabling along the boom extension to a Smartport mounted on the Electronics Deck.

4.4.4 Thermal Interface

The thermal interface for instruments placed on the boom is the same as for the exposure deck. Any thermal control will be negotiated with the DSTB management through the ICD process.

5.0 Instrument Requirements

5.1 Power Requirements

The power subsystem for the DSTB provides power to the DSTB FCDS, the DSTB standard radiation monitors and the investigators' instruments. The SIP that contains the balloon flight control equipment obtains power from its own separate solar panels.

5.1.1. The instruments aboard DSTB shall operate on the shared 600 watts of power received from the power system for the duration of the balloon flight (maximum of 30 days). Actual watts per instrument shall be determined on a case by case basis.

5.1.2. The instrument shall operate on the provided unconditioned 28 ± 6 VDC.

5.1.3. The instrument shall use quick disconnect connectors provided by the DSTB for power delivered by the DSTB.

5.1.4. The instrument shall have critical hardware identified and labeled for recovery purposes.

5.1.5. The instruments shall be prepared at integration to comply with DSTB recommendations to reduce noise (spikes, transitions) back in to the Power Subsystem.

5.1.6 The instrument shall be connected to the power system through a commandable circuit breaker provided by the DSTB project.

5.2 Thermal Requirements

Thermal requirements are derived from the Antarctic environments during launch, ascent, and at altitude. The FCDS will be turned on and running during the launch operations and ascent. The environmental extremes occur during ascent (cold (-75°C / -103°F); convective, conduction) and at altitude (hot (75°C / 167°F), radiant, conductive). It is the goal of the DSTB to maintain the thermal operating temperature of the instruments by passive means.

5.2.1. The instruments shall withstand thermal operating temperatures between 0° and 50°C (32° and 112°F).

5.2.2. The instruments shall withstand Pressures between 0.987 and 0.00296 atm. (1000 and 3 millibars)

5.2.3. The instruments shall supply the DSTB with thermal model inputs

5.3. FCDS Requirements

5.3.1. The instruments shall transfer data and communicate to the FCDS through provided connections.

5.3.2. The instruments shall receive commands through the FCDS from the ground station through the command link in a serial stream of the experimenters choosing.

5.3.3. The instruments shall send science data to the FCDS in a serial stream of the experimenters choosing.

5.3.4. The instruments shall have an average of 1 Gigabyte of storage space for data on the FCDS.

5.3.5. The instruments aboard the DSTB shall interface with the FCDS to share downlink capabilities.

5.4. Mechanical Requirements

5.4.1. The instruments on the exposure deck shall interface with the provided removable mounting plates.

5.4.2 The instrument located on the electronics deck shall be handled on a case by case basis and the requirements for an individual instruments shall be given in that instruments' ICD.

5.4.3. The instruments shall withstand a side acceleration of 5 g and 10 g acceleration down.

5.4.4. The instrument shall be constructed of materials that do not depart from tensile strength used in load calculations or have thermal expansion sufficient to overstress fasteners etc.

5.4.5. The total instrument weight on an exposure deck panel shall not exceed 150 lbs (68.04kg), not including the 14.5 lb (6.58kg) panel.

5.4.6. The instruments located on the outside panels shall fit within the volume shown in Figure 6.

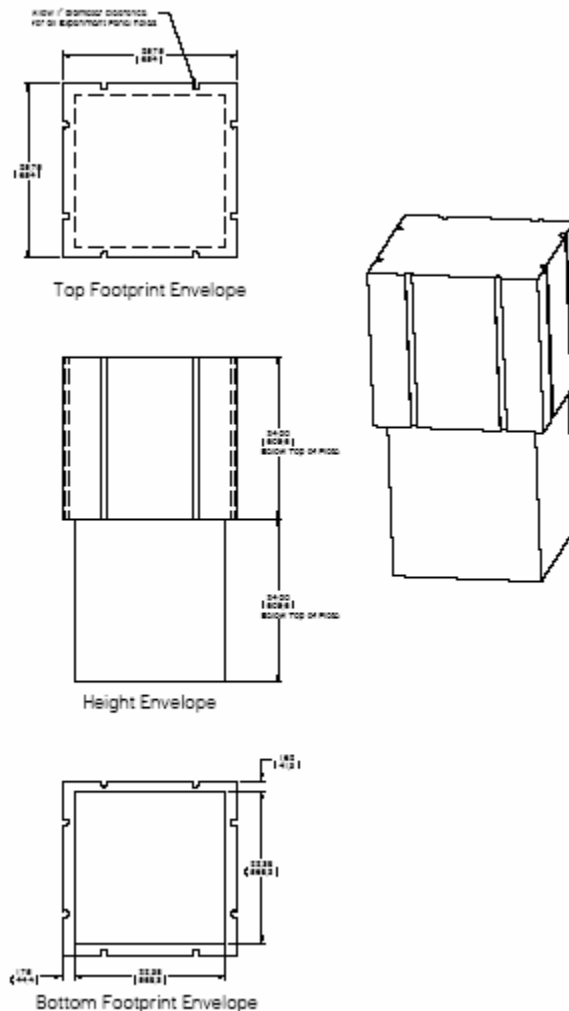


Figure 6: Exterior Panel Volume

5.4.7. The weight of the materials on the Carousel shall not exceed 45 lbs (20.4 kg) total. This weight will be divided among the materials selected for the flight.

5.4.8. The materials located on the Carousel shall use the attach points shown in Figure 7 and not exceed 8" (20.32cm) in Height. A total of 5 attach points are available. The holes are located on flanges which are 0.15 inch (0.38 cm) thick aluminum. Each attach point is a 0.25 inch (0.64cm) diameter hole. Any fastener used should not stick more than 0.2 inches (0.51 cm) of the detectors). While these five attach points are available, it is recommended that the weight be distributed along the lip for each section. This is recommended for test materials (irradiated material) that are at the upper limit of the allowable weight (45 lbs/20.4 kg).

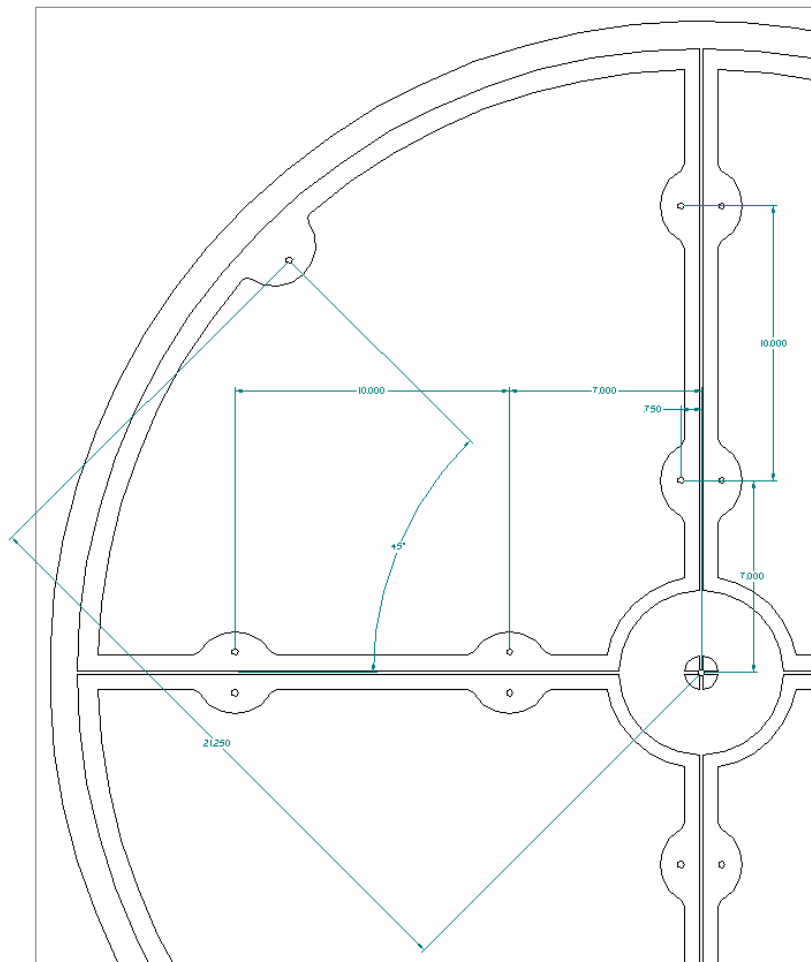


Figure 7: Carousel Attach Points

5.4.9. The Boom instruments weight and CG shall fall within the parameters listed in Table 2.

Angle Size (in inches)	Boom Length = 4 feet (from Corner Post)		Boom Length = 6 feet (from Corner Post)		Boom Length = 8 feet (from Corner Post)		Boom Length = 10 feet (from Corner Post)	
	Maximum Experiment Weight (lb)	Weight of Boom (lb)	Maximum Experiment Weight (lb)	Weight of Boom (lb)	Maximum Experiment Weight (lb)	Weight of Boom (lb)	Maximum Experiment Weight (lb)	Weight of Boom (lb)
2 x 2 x .125	5.35	3.59	4.33	4.75	3.15	5.92		
2 x 2 x .188	7.54	5.31	6.01	7.03	4.24	8.75	2.42	10.48
2.5 x 2.5 x .188	14.08	6.70	11.20	8.88	8.24	11.05	5.46	13.22
3 x 3 x .188	23.04	8.10	18.20	10.72	13.63	13.35	9.60	15.97
3 x 3 x .25	29.26	10.65	22.92	14.10	16.98	17.56	11.77	21.01
3.5 x 3.5 x .25	44.05	12.50	34.27	16.56	25.70	20.61	18.52	24.67
4 x 4 x .25	62.20	14.35	48.05	19.01	36.26	23.66	26.74	28.32
4 x 4 x .375	86.72	21.18	66.32	28.05	49.49	34.92	35.96	41.80
* Center of Gravity of experiment must be kept within 5" of angle corner horizontally and vertically								
Angle Size (in inches)	Boom Length = 1.22 m		Boom Length = 1.83 m		Boom Length = 2.44 m		Boom Length = 3.05 m	
	Maximum Experiment Weight (kg)	Weight of Boom (kg)	Maximum Experiment Weight (kg)	Weight of Boom (kg)	Maximum Experiment Weight (kg)	Weight of Boom (kg)	Maximum Experiment Weight (kg)	Weight of Boom (kg)
2 x 2 x .125	2.43	1.63	1.97	2.16	1.43	2.68		
2 x 2 x .188	3.42	2.41	2.73	3.19	1.92	3.97	1.10	4.75
2.5 x 2.5 x .188	6.39	3.04	5.08	4.03	3.74	5.01	2.48	6.00
3 x 3 x .188	10.45	3.67	8.25	4.86	6.18	6.05	4.36	7.24
3 x 3 x .25	13.27	4.83	10.40	6.40	7.70	7.96	5.34	9.53
3.5 x 3.5 x .25	19.98	5.67	15.55	7.51	11.66	9.35	8.40	11.19
4 x 4 x .25	28.21	6.51	21.79	8.62	16.45	10.73	12.13	12.85
4 x 4 x .375	39.34	9.61	30.08	12.73	22.45	15.84	16.31	18.96
* Center of Gravity of experiment must be kept within 12.7 cm of angle corner horizontally and vertically								

Table 2: Boom Length and Allowable Weight

5.5. General Requirements

5.5.1 Instruments shall have no radioactive sources.

5.5.2 Instruments and investigators will comply with the xD50 Safety Plan for General Laboratory Work at the NSSTC.

5.5.3 Instruments and investigators will comply is the NSBF Ground Safety Plan at all NSBF sites.

6.0 Field and Ground Operations

The DSTB ground development and integration facility is located at the National Space Science and Technology Center (NSSTC) in Huntsville, AL. The DSTB team at NSSTC will provide resources, equipment, and personnel for the assembly of each flight gondola and the integration and operational tests of approved flight payload systems. These efforts will be provided for each long duration expedition as well as any CONUS test flight that

may be required. The facility and its resources will be available to support post-mission activity for the de-integration of payloads.

The NSSTC ground facility includes a visitor's office area as well as laboratory work space for use by visiting personnel during site visits for the integration and testing phases of planned flight expeditions. This space is located within laboratory room # 1218 of the NSSTC annex building. Access to the building and work areas is by magnetic ID badges which will be issued to visitors at initial check in. The visitor space provides a general use computer (unsecured internet access), telephones, workbenches, meeting tables, refrigerator and sink area, etc. The area serves as an on-site base of operations for DSTB visitors to Huntsville and includes handling equipment such as carts and lifts. Filing cabinet and some storage space for each experiment group can also be provided. Access to adjacent lab facilities of the local supporting Cosmic Ray research group is also available, on an individual request basis, for use of special need items such as bottled gases, liquid nitrogen, dry ice, or distilled water. These labs may also provide temporary use of some general laboratory equipment such as weigh scales, vacuum chambers, vacuum ovens, oscilloscopes, and some nuclear instrument modules for on-site use. A small contractor run machine shop is on site and may perform small jobs in an emergency. Use of radioactive materials for investigation experiments in any capacity will require coordination with and pre-approval by the NSSTC visitor coordinator. No radioactive materials are allowed into the NSSTC buildings without prior radiation safety officer approval.

A final pre-shipment gondola/payload weight and fit exercise will be performed at the Huntsville facility prior to shipment of the DSTB to Palestine, TX or Ft. Sumner, NM for the NASA/NSBF integration process, which is a procedure for all experiments bound for LDB flight operations. This ground check-out exercise will include a gondola hang test with full-up solar panel power operation for all instruments requiring power. Dummy loads will be used where it is not practical to utilize the actual flight equipment. Each investigator should plan to either deliver their DSTB provided instrument panel with the attached hardware in place for this exercise (including appropriate cables and connectors) ready for integration into the gondola system or allow sufficient preparation time to perform the attachment on-site at the Huntsville ground facility. Thermal coverings, if planned, can be affixed during final check-out either at Palestine, TX or Ft Sumner, NM. At the conclusion of the Huntsville exercise, which will involve an integrated gondola/payload shipping assessment, the gondola and instruments will be shipped to Palestine. Each investigator will be responsible for the shipping logistics of any ground support equipment required at Palestine.

The following is a listing of government furnished resources and equipment available at the Huntsville ground operations site.

1. 2000 ft² (185.81m²) of high bay, laboratory and office space /w visitor PC and internet connections
2. Deep Space Test Bed gondola and general solar panel based power system
3. Mobile work tables
4. Medium and heavy duty lifting and moving equipment
 - a. 500lb (226.80 kg) capacity (mobile) electric hoist

- b. 10 ton (9,071.85 kg) electric traveling crane (high bay)
- c. Fork lift
- d. 500 lb. (226.80 kg) capacity (mobile) laboratory hydraulic lift cart
- e. Engine hoist
- 5. Machine shop facility (small jobs)
- 6. DSTB Low level radiation sources (alpha, beta and neutron)
- 7. High wattage AC powered DC power supply (0-35V, 750 W)
- 8. Optical light pulser (100ps)
- 9. Distilled water
- 10. Weigh scales
- 11. Portable air conditioner
- 12. Bottled gases
- 13. Liquid Nitrogen
- 14. Small vacuum chamber access
- 15. Vacuum oven access
- 16. Ultrasonic cleaner access
- 17. Clean room access
- 18. Other Items

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